# Chapter 1
# Introduction

## 1-1. Purpose

This manual provides technical specifications and procedural guidance for control and geodetic surveying. It is intended for use by engineering, topographic, and construction surveyors performing control surveys for civil works, military construction, and environmental restoration projects. Procedural and quality control standards are defined to establish uniformity in control survey performance and contract administration.

## 1-2. Applicability

This manual applies to all USACE commands having responsibility for the planning, engineering and design, operations, maintenance, construction, and related real estate and regulatory functions of civil works, military construction, and environmental restoration projects. It applies to control surveys performed by both hired-labor forces and contracted survey forces.

## 1-3. Distribution

This publication is approved for public release; distribution is unlimited.

## 1-4. References

Referenced USACE publications are listed in Appendix A. Where applicable, bibliographic information is listed within each chapter or appendix.

## 1-5. Background

A geodetic control survey consists of establishing the horizontal and vertical positions of points for the control of a project or installation site, map, GIS, or study area. These surveys establish three-dimensional point positions of fixed monuments, which then can provide the primary reference for subsequent engineering and construction projects. These control points also provide the basic framework from which detailed site plan topographic mapping, boundary demarcation, and construction alignment work can be performed. Precisely controlled monuments are also established to position marine construction vessels supporting the Corps navigation mission--e.g., the continuous positioning of dredges and survey boats. Geodetic control survey techniques are also used to effectively and efficiently monitor and evaluate external deformations in large structures, such as locks and dams.

## 1-6. Scope of Manual

This manual covers the use of engineering surveying techniques for establishing and/or extending project construction control. Accuracy requirements, standards, measurement procedures, calibrations, horizontal and vertical datum transformations, data reduction and adjustment methods, and engineering surveying techniques are outlined. The primary focus of this manual is on conventional (i.e., non-GPS) horizontal and vertical survey techniques using traditional ground survey instruments--transits, theodolites, levels, electronic total stations, etc. Typically, conventional survey techniques include traverse, triangulation, trilateration, and differential leveling.

*a*. The manual is intended to be a reference guide for control surveying, whether performed by in-house hired-labor forces, contracted forces, or combinations thereof. General planning criteria, field and office execution procedures, project datum requirements, and required accuracy specifications for performing engineering surveys are provided. Accuracy specifications, procedural criteria, and quality control requirements contained in this manual should be directly referenced in the scopes of work for Architect-Engineer (A-E) survey services or other third-party survey services. This ensures that standardized procedures are followed by both hired-labor and contract service sources.

*b*. The survey performance criteria given in this manual are not intended to meet the Federal Geodetic Control Subcommittee (FGCS) standards required for densifying the National Geodetic Reference System (NGRS). However, the methods and procedures given in this manual will yield results equal to or exceeding FGCS Second Order relative accuracy criteria. Second Order accuracy is generally considered sufficient for most USACE engineering and construction work.

*c*. This manual does not cover the concepts of using differential GPS for performing precise geodetic control surveys. For further specific guidance on all aspects of GPS surveying, the user should consult EM 1110-1-1003, NAVSTAR GPS Surveying.

*d*. This manual should be used in conjunction with other USACE surveying and mapping engineering manuals that refer to it for guidance on datums and datum transformation procedures. These procedures are covered in Chapter 4 (Reference Systems and Datum Transformations) and in Appendices B, C, and D.

*e*. This manual was initially developed as part of the 31 October 1994 version of EM 1110-1-1004, "Deformation and Control Surveying." During the current update, structural deformation surveying portions of the 1994 manual were removed and incorporated into a separate technical manual. The current version of EM 1110-1-1004 was then re-titled as "Geodetic and Control Surveying" to reflect the revised scope.

## 1-7. Life Cycle Project Management

Project control surveys may be required through the entire life cycle of a project, spanning decades in many cases. During the early planning phases of a project, a comprehensive control plan should be developed which considers survey requirements over a project's life cycle, with a goal of eliminating duplicate or redundant surveys to the maximum extent possible.

## 1-8. Metrics

Both English and metric units are used in this manual. Metric units are commonly used in precise surveying applications, including the horizontal and vertical survey work covered in this manual. Control survey measurements are usually recorded and reported in metric units. In all cases, the use of either metric or English units shall follow local engineering and construction practices.

## 1-9. Trade Name Exclusions

The citation or illustration in this manual of trade names of commercially available survey products, including other auxiliary surveying equipment, instrumentation, and adjustment software, does not constitute official endorsement or approval of the use of such products.

## 1-10. Abbreviations and Terms

Abbreviations used in this manual are defined in the Glossary at the end of this manual. Commonly used engineering surveying terms are also explained in the Glossary.

## 1-11. Mandatory Requirements

ER 1110-2-1150 (Engineering and Design for Civil Works Projects) prescribes that mandatory requirements be identified in engineer manuals. Mandatory requirements in this manual are summarized at the end of each chapter. Mandatory accuracy standards, quality control, and quality assurance criteria are normally summarized in tables within each chapter. The mandatory criteria contained in this manual are based on the following considerations: (1) project safety considerations, (2) overall project function, (3) previous Corps experience and practice has demonstrated the criteria are critical, (4) Corps-wide geospatial data standardization requirements, (5) adverse economic impacts if criteria are not followed, and (6) HQUSACE commitments to Federal and industry standards.

## 1-12. Proponency

The HQUSACE proponent for this manual is the Engineering and Construction Division, Directorate of Civil Works (CECW-EE). Technical development and compilation of the manual was coordinated by the US Army Topographic Engineering Center (CEERD-TS-G). Comments, recommended changes, or waivers to this manual should be forwarded through MSC to HQUSACE (ATTN: CECW-EE).